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## PATENT SPECIFICATION

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### COMPLETE SPECIFICATION

#### Vinyl Chloride Polymer Compositions and methods for making Open-Cell Vinyl Chloride Polymer Foams

We, GENERAL MOTORS CORPORATION, a Company incorporated under the laws of the State of Delaware, in the United States of America, of Grand Boulevard, in the City of Detroit, State of Michigan, in the United States of America (Assignees of HAROLD EDWARD SCHWELLER, JAMES EDWARD PARRISH and DAVID MAURICE STOWE) do hereby declare the invention for which we pray that a patent may be granted to us and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to vinyl chloride polymer compositions and methods for making open-cell vinyl chloride polymer foams.

According to the invention, a composition which is capable of being mechanically frothed with air to produce an open-cell vinyl chloride polymer foam comprises a vinyl chloride polymer plastisol and, uniformly dispersed in the plastisol, a toluene-soluble siloxane copolymer resin consisting essentially of  $R_3SiO_{\frac{1}{2}}$  monovalent units and  $SiO_2$  tetravalent units in a ratio of monovalent units to tetravalent units from 0.3 to 0.7, where R is an alkyl radical, a monocyclic aryl hydrocarbon radical, or a halogenated monocyclic aryl hydrocarbon radical. In the foregoing formula, the " $\frac{1}{2}$ " is inserted as a subscript after the oxygen symbol to indicate that the oxygen atom in the unit is shared with a silicon atom in a different unit.

Where R is an alkyl radical, it preferably has not more than five carbon atoms.

A mixture of more than one of the said toluene-soluble siloxane copolymer resins could be used if desired.

The plastisol may comprise a vinyl chloride homopolymer and a plasticizer. The plastisol

may contain 100 parts by weight of the vinyl chloride homopolymer, 50 to 150 parts by weight of the plasticizer, and 1 to 10 parts by weight of the toluene-soluble siloxane copolymer resin.

The invention also includes a method of producing an open-cell vinyl chloride polymer foam by mechanically entraining air into a composition as aforesaid to form a liquid foam, heating to induce fusion into an open-cell foam structure, and cooling to ambient temperature.

The invention also includes an open-cell vinyl chloride polymer foam produced by the said method.

Also within the scope of the invention is a flexible vinyl chloride polymer foam having a fine, uniform open-cell structure and comprising a vinyl chloride polymer plastisol foam containing a toluene-soluble siloxane copolymer resin consisting of  $R_3SiO_{\frac{1}{2}}$  monovalent units and  $SiO_2$  tetravalent units in a ratio of monovalent units to tetravalent units from 0.3 to 0.7, where R is an alkyl radical, a monocyclic aryl hydrocarbon radical, or a halogenated monocyclic aryl hydrocarbon radical.

To produce the composition as aforesaid, the toluene-soluble siloxane copolymer resin, preferably at a concentration of 50 to 70% by weight solids in the toluene solution, may first be incorporated in the vinyl chloride polymer plastisol. The plastisol may itself be a conventional formulation containing a vinyl chloride homopolymer or copolymer resin and a plasticizer, together with filler, stabilizer or pigment as required.

When the plastisol formulation has been thoroughly blended and is ready to be formed or moulded into a predetermined foamed con-

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figuration, air may be whipped or beaten into the composition at ambient temperature by mechanical means, this foaming operation conveniently being conducted at about room temperature. A useful foam may be prepared using ambient air, that is, at atmospheric pressure. Alternatively, compressed air may be employed, whereby greater amounts can be entrained in the liquid foam. In general, the more air that is incorporated into the foam or froth, the lower the density of the finished product.

The presence of a polysiloxane prefoamer in the plastisol composition stabilizes the air bubbles in the plastisol for some time. However, the foam will start to collapse upon prolonged standing. Therefore, it is preferred that rapid heating be commenced to gel and fuse the composition within five to ten minutes after the liquid foam has been generated.

The plastisol is fused by heating to an elevated temperature which is dependent upon the resins and plasticizers employed, as well as the thickness and density of the foam. In general, after formation of the foam into a desired shape as by spreading or pouring into a mould, it is heated at a temperature of 300° F. to 375° F. for from thirty seconds to two hours to gel and fuse it. Gelation can be effected as a separate operation by heating at a temperature from 140° F. to 190° F. for about ten seconds to about two hours. In this period the liquid foam solidifies to a soft gel. Fusion is then obtained as a separate operation by further heating at 300° F. to 375° F. for from thirty seconds to two hours. In general, it is preferred that the liquid foam be rapidly heated to about 350° F. so that gelation and fusion are completed in twelve to fifteen minutes. As fusion occurs, discrete closed cells present in the liquid foam become interconnecting or open-cell. After heating, the fused foam is cooled to room temperature. The finished product is a flexible foam material having open cells of relatively uniform size. Depending upon the amount of air that has been incorporated into the plastisol, foam densities may be obtained over a wide range from about 10 pounds per cubic foot up to about the solid density of the plastisols of this type, in excess of 70 pounds per cubic foot.

A vinyl chloride polymer plastisol is a two-phase system in which a vinyl chloride polymer in small particulate form is dispersed and suspended in a plasticizer for the polymer which has little or no solvating action on the polymer at room temperature but will dissolve the polymer at elevated temperatures and cause it to fuse into a plasticized structure. The vinyl chloride polymer may be a vinyl chloride homopolymer, or it may be a copolymer (e.g. terpolymer) of vinyl chloride with other ethylenically unsaturated monomers, or a mixture of the homopolymer with other vinyl chloride copolymers (e.g. terpolymers), and

particularly those vinyl chloride polymers containing a predominant amount of vinyl chloride polymerized therein, namely at least fifty per cent by weight. The preferred vinyl chloride polymers employed in this invention are those containing from 60 to 100 per cent by weight of vinyl chloride in polymeric form.

The ethylenically unsaturated monomers which may be polymerized with vinyl chloride to form the copolymers, (e.g. terpolymers) include, for example, lower alkyl unsaturated esters, particularly vinyl acetate, partially hydrolyzed vinyl acetate, and vinyl benzoate, lower alkyl acrylates such as methyl acrylate, ethyl acrylate, butyl acrylate and octyl acrylate, and the corresponding methacrylates, alkyl esters of unsaturated acids such as maleic and fumaric acids, such as diethyl maleate, and other copolymerizable compounds such as unsaturated nitriles, for example acrylonitrile, halogenated hydrocarbons such as vinylidene chloride and fluoride, vinyl fluoride, chlorotrifluoroethylene, and other polymerizable compounds containing ethylenic unsaturation. Copolymers which are particularly preferred are the vinyl chloride-vinyl acetate copolymers, particularly those containing 85% by weight or more of vinyl chloride polymerized therein.

Typical vinyl chloride polymers which are commercially available at least from U.S. manufacturers and can be used include vinyl chloride homopolymer dispersion grade resins, such as those currently available under the trade names Geon 121 (Geon is a Registered Trade Mark of B. F. Goodrich Chemical Co.); Marvinol VR-10, 15, 24, 50, 51, 53 (Uniroyal); GYLF-Z (Union Carbide); PVC-74 (Diamond Alkali); Tenneco 1755 (Tenneco Plastics); Opalon 410 and 440 (Opalon is a Registered Trade Mark of Monsanto Chemical Co.) and vinyl acetate-vinyl chloride copolymers such as Tenneco 0565, Opalon 3142, Marvinol VR-56 and 57, and VC-265 (Borden Chemical Co.). In this list, the names in brackets are those of U.S. manufacturers of the respective dispersion grade resins.

Assuming a total vinyl chloride polymer content in the plastisol of 100 parts by weight, up to about 40 parts of this amount may include a larger particle size vinyl chloride polymer resin, such as Marvinol VR-10, 15, 24 or VC-265 above. The use of these large-particle resins, commonly referred to as blending resins, decreases the viscosity of the plastisol and increases cell size or openness of the finished structure in proportion to the amount of this type of resin employed.

The liquid plasticizer present in the plastisol as a dispersion medium for the above-described resin particles is used in varying amounts depending upon the resin employed and the desired properties of the final product. In accordance with the invention, it is generally preferred that 50 to 150 parts by

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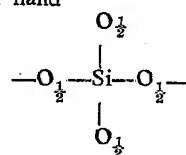
weight of the plasticizer(s) be employed per 100 parts resin. Typical plasticizers include: simple esters, such as butyl-benzyl phthalate, dodecyl phthalate, tricresyl phosphate, trioctyl trimellitate, *n*-octyl *n*-decyl trimellitate (NONDTM), tri-*iso*-octyl trimellitate, di-propylene glycol dibenzoate; polymeric plasticizers, such as those currently available under the trade names Nuoplad 1046 (Nuodex Company), Paraplex G-54, G-62 (Paraplex is a registered Trade Mark of Rohm & Haas), Santiciser 140, 148 and 462 (Santiciser is a Registered Trade Mark of Monsanto), Staflex 347 (Reinhold Chemicals); epoxy-type plasticizers, such as Monoplex S-73 and S-75 (Rohm & Haas), this latter having at one time been available as "Plasticiser XP-2007", Admex 752 (Archer, Daniels & Midland), and Emery 1276-40-R (Emery Industries, Inc.); and chlorinated paraffin oils, such as Flexicore 50-T. In the foregoing, the names in brackets are again those of the U.S. manufacturers. One or more plasticizers may be employed as desired.

In addition to the vinyl chloride polymer resin and the liquid plasticizer, the vinyl chloride polymer resin plastisols may contain various conventional additives. Normally heat and light stabilizers are employed, such as complexes of barium, zinc, cadmium, lead, tin and/or calcium salts of fatty acids. Examples of commercial materials include Barca 10 (Reinhold Chemical Company); Vanstay HTA (Vanderbuilt); Ferro 5730 (Ferro is a Registered Trade Mark of Ferro Chemical Co.); Nuodex V-1048 (Nuodex is a Registered Trade Mark of Tenneco); Advance BC-72, Advance T5, Advance Liquid T150 (Advance Chemical Co.); and Dyphos paste (National Lead). Preferably such stabilizers are included in an amount of 1-4 parts per 100 parts of total vinyl chloride polymer resin.

Inert fillers, pigments and extenders, for example, are incorporated when suitable for colour or for economic reasons. When included they are preferably added to the plastisol in amounts up to about 100 parts by weight per 100 parts of resin. Examples of suitable filler-extenders are calcium carbonate, barytes, and mica. Low-oil-absorbing fillers are preferred.

Of critical importance to the practice of the invention is the incorporation with the plastisol of one or more members of a specific class of siloxane copolymer resins. The subject siloxane copolymers are crystalline substances which preferably are added to the plastisol as a solution in toluene or other suitable solvent such as benzene or xylene. The solvent is normally necessary for uniform incorporation of the siloxane copolymer into the plastisol formulation. However, the solvent does not contribute to the acceptance of air by the plastisol. Preferably, 1 to 10 parts by weight of the siloxane copolymer on a solvent-free

basis is employed per 100 parts total vinyl resin. The siloxane prefoamer resin is a copolymer consisting of monovalent units,  $R_3SiO_{\frac{1}{2}}$ , and tetravalent units  $SiO_2$ . In the context of this invention the valency of a unit is measured by the number of other units with which it can form a bond. For example, the  $R_3SiO_{\frac{1}{2}}$  unit, where R is defined as below, can form a bond with one other siloxane unit. On the other hand



can form bonds with four other siloxane units. The " $\frac{1}{2}$ " is inserted as a subscript after the oxygen symbol to indicate that the oxygen atom in the unit is shared with a silicon atom in a different unit. In conformity with the present invention, the ratio of monovalent units to tetravalent units in the copolymer is from 0.3 to 0.7. The R group is preferably a methyl group, but can be another alkyl radical, preferably having five carbon atoms or less, a monocyclic aryl radical, or a halogenated monocyclic aryl radical. Substitution of ethyl, propyl, butyl, or phenyl groups, for example, for one or more of the methyl groups will change the viscosity of the plastisol formulation but does not substantially affect the ability of the plastisol to accept air. Copolymers of this type may be prepared by the co-hydrolysis and immediate subsequent copolymerization of hydrolyzable monofunctional and tetrafunctional silanes. For example, trimethyl chlorosilane and tetrachlorosilane or ethyl orthosilicate may be co-hydrolyzed and immediately copolymerized to form a copolymer of  $(CH_3)_3SiO_{\frac{1}{2}}$  and  $SiO_2$  units wherein the ratio

of the monovalent unit to the tetravalent unit in the copolymer is 0.3 to 0.7. The terminating groups of the copolymer are primarily the monovalent units. These materials are used as intermediates in the production of siloxane adhesives, and are commercially available.

A vinyl chloride polymer plastisol suitable for foaming in accordance with the invention may be prepared in the following manner. The dry ingredients including vinyl chloride polymer resin, stabilizers, fillers and pigments are combined. The plasticizers (if more than one is employed) are combined. The dry ingredients are combined with the plasticizer in a conventional manner, as by adding the plasticizer to the dry ingredients, or *vice versa*. If the plasticizer is added to the dry ingredients, preferably it is metered in until a solid-to-liquid phase change is observed. Mixing is then continued for about five minutes at maximum shear before the remaining plasticizer

is added. The remaining plasticizer is then added and mixing is continued until a uniform plastisol is obtained. When dry ingredients are added to the plasticizer, the operation is accompanied by mixing, and the mixing continued until the plastisol is uniform. After the conventional plastisol is substantially uniform in texture, the polysiloxane resin is added to it with slow agitation. When this addition has been completed the plastisol is ready for foaming. The plastisol viscosity preferably is 1,000 to 15,000 cps (Brookfield spindle No. 4 and 30 r.p.m.). The mixing of the plastisol components is preferably accomplished at room temperature.

To prepare a liquid foam the plastisol is mechanically beaten or whipped to entrain air therein. This may be accomplished by mechanical device such as for example a kitchen-type mixer (for instance a Hobart N-50 kitchen-type mixer), or an E. T. Oakes continuous mixer, which is an enclosed system in which air, usually compressed air, is mixed into fluid material. Hobart and Oakes are Registered Trade Marks. The Hobart mixer uses a planetary action with a wire whip and differs from the continuous-type mixer in that it incorporates air by whipping in a bowl without use of an enclosed system or compressed air. The volume of air that can be incorporated by entraining air directly from the atmosphere is less than can be incorporated by employing compressed air. It has been found that the volume of air that can be incorporated with a Hobart mixer is about one-third of that possible with the Oakes continuous mixer.

When air has been whipped into the plastisol, the liquid foam can be processed by any of a number of techniques known in the art of foam technology. For example, it can be doctored into slab form or used to fill open or closed moulds. Fusion of the foam is accomplished by dry heat in the case of slab materials, or either dry heat or liquid heat (molten salts, for example) in the case of completely closed mould systems. The temperature of fusion is dependent upon the choice of resin and plasticizer. The time for fusion is a function of heat transfer and thickness of the layer being heated.

The cell structure of the resulting foam is open and generally uniform. The size of the cells is dependent upon a number of factors. In general, the higher the density of the finished product the finer (smaller) the cell structure that is obtained. As indicated above, the density is a function in part of the amount of air entrained in the plastisol. The density is also a function of the resins used. For example, in a typical system employing no more than about 10% by weight blending resin and wherein there is only a short time between foaming and fusing, foam densities of 35 pounds per cubic foot produce a cell diameter in the range of 0.001" to 0.010". At a foam density of 22 pounds per cubic foot the cell diameters have ranged from 0.005" to 0.030". The use of relatively large-particle vinyl chloride polymer resins, such as Marvinol VR-10, 15, 24 or VC-265, increases cell size or openness of the foam structure in proportion to the amount of this type of resin employed. When the blending resin represents about 20% of the total resin content of the plastisol, the cell size of the finished foam is about twice that of a formulation with no such resin. With 30% of the total resin content of the plastisol being the large-particle resin, the cells of the finished foam are approximately three times the cell size of a foam produced from a formulation with no such resin. This is considered to be due to a reduction in the viscosity of the plastisol by the resin. Thin foams can be made by employing higher proportions of such resins and/or high plasticizer levels. This type of foam is easier to foam but will collapse more rapidly.

The following Examples further illustrate the invention. Where trade names are used in the Examples to designate the various components, namely the vinyl chloride polymers and the plasticizers and stabilizers, the names of the U.S. manufacturers of these components, and the general chemical nature of the components, will be found in the preceding part of the specification.

#### EXAMPLE 1.

Two batches of plastisol formulations were prepared of the compositions summarized in the following Table:—

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Components	Parts by weight	
	No.1	No.2 (Control composition)
Vinyl chloride polymer Tenneco 1755	90	90
Vinyl chloride polymer VC-265	10	10
Stabilizer Nuodex V-1048	3	3
Plasticizer NONDTM	40	40
Plasticizer XP-2007	20	20
Plasticizer Santiciser 140	10	10
Siloxane resin (50% by weight in toluene) copolymer of $(\text{CH}_3)_3\text{SiO}_2$ units (a) and $\text{SiO}_2$ units (b), ratio of (a) to (b) 0.6	4	0
<u>Physical Properties of the Plastisol</u>		
Viscosity Brookfield CPS	1500	1500
<u>Physical Properties of Finished Foam</u>		
Hobart mixer: Foam Density lb./cu.ft.	30—35	No foam was formed
Oakes foamer: Foam Density lb./cu.ft.	20—25	No foam (75 lb/cu ft <sup>3</sup> )

5 The distinction between compositions No. 1 and No. 2 is that No. 2 is a control composition containing no siloxane copolymer. A portion of composition No. 1 was foamed in a Hobart batch mixer using a wire whip, and a second portion was foamed in a 4M Oakes foamer at a rotor speed of 550 r.p.m. using 200 p.s.i. compressed air. Portions of plastisol composition No. 2 were processed in a similar manner. The unfoamed plastisol in each instance had a Brookfield viscosity of 1500 cps (No. 1 spindle, 30 r.p.m.). After an attempt was made to generate a liquid foam with both compositions, each of the individual specimens was gelled and fused by heating. Each portion of the No. 1 composition plastisol pro-

duced a flexible, uniform cell foam with the density cited in the above Table. The density of the foam produced from the liquid foam generated in the Oakes foamer was lower because more air was incorporated. The No. 2 composition, containing no prefoamer, could not be foamed by whipping air therein.

#### EXAMPLE 2.

This Example illustrates the plastisol compounding latitude with respect to various vinyl resins.

A number of plastisol formulations were prepared by the method of Example 1, the compositions of the respective formulations being summarized in the following Tables:—

Components	Parts by Weight				
	A	B	C	D	E
Vinyl chloride polymer Tenneco 1755	90				
Vinyl chloride polymer Tenneco 0565		90			
Vinyl chloride polymer Marvinol VR-50			90		
Vinyl chloride polymer Marvinol VR-56				90	
Vinyl chloride polymer Opalon 440					90
Vinyl chloride polymer VC-265	10	10	10	10	10
Plasticizer XP-2007	20	20	20	20	20
Plasticizer NONDTM	40	40	40	40	40
Plasticizer Santiciser 140	10	10	10	10	10
Stabilizer Nuodex V-1048	3	3	3	3	3
Siloxane resin (50% by weight in toluene)—copolymer of (CH <sub>3</sub> ) <sub>3</sub> SiO <sub>2</sub> <sup>1/2</sup> units (a) & SiO <sub>2</sub> units (b), ratio of (a) to (b) 0.6	4	4	4	4	4
Total	177	177	177	177	177
Physical Properties					
Visc. Brookfield CPS	1100	1100	4000	4000	3000
Hobart mixer: Density (lb./cu.ft.)	30—35	30—35	35—40	35—40	30—35
Oakes foamer Density (lb./cu.ft.)	20—25	20—25	25—30	25—30	20—25
Gelation Temp. °F.	165	160	220	160	220
Fusion Temp. °F.	350	310	350	310	350

5 In each instance, foaming by procedures as described in Example 1 produced satisfactory finished foams of fine uniform open-celled structures. The viscosity of the plastisol prior to foaming, the density of the foams produced, and the gelation temperatures and fusion temperatures are summarized above.

pounding latitude with respect to plasticizers. 10

A number of compositions are summarized below were prepared, and air was whipped into the compositions, without subsequent gelling and fusing, by procedures as described in Example 1. The Brookfield viscosity of the un- 15  
foamed plastisol as well as the finished foam densities and processing temperatures are summarized in the following Table:—

EXAMPLE 3.  
This Example illustrates the plastisol com-

Components	Parts by Weight					
Vinyl chloride polymer Tenneco 1755	90	90	90	90	90	90
Vinyl chloride polymer VC-265	10	10	10	10	10	10
Plasticizer XP-2007	30					
Plasticizer NONDTM	40			40		
Plasticizer Nuoplad 1046		70	70			
Plasticizer Staflex 347						
Plasticizer Emery 1276—40—R				30	70	
Plasticizer Santiciser 148						70
Stabilizer Nuodex V-1048	3	3	3	3	3	3
Siloxane resin (50% by weight in toluene)—copolymer of $(\text{CH}_3)_3\text{SiO}_{\frac{1}{2}}$ units (a) and $\text{SiO}_2$ units (b), ratio of (a) to (b) 0.6	4	4	4	4	4	4
Physical Properties						
Visc. Brookfield CPS	1100	1000	2000	20,000	5000	800
Hobart mixer: Density (lb./cu.ft.)	30—35	30—35	45—50	33—35	40—45	30—35
Oakes foamer: Density (lb./cu.ft.)	20—25	18—25	35—40	25—30	30—35	20—25
Gelation Temp. (°F.)	170	142	160	160	160	160
Fusion Temp. (°F.)	350	300	340	350	320	280—300

In each instance a satisfactory foam of fine uniform open-cell structure was obtained.

## EXAMPLE 4.

This Example illustrates the compatability of a number of different vinyl stabilizers in plastisol compositions containing the poly-

5 siloxane prefoamer of this invention.

Plastisols were prepared having the com-

position and physical properties summarized below in the following Table, and were foamed, gelled and fused by procedures as described in Example 1. In each instance a satisfactory foam having a fine uniform open-cell structure was obtained. 10

Components	Parts by Weight				
Vinyl chloride polymer Tenneco 0565	80	80	80	80	80
Vinyl chloride polymer VC-265	20	20	20	20	20
Plasticizer XP-2007	20	20	20	20	20
Plasticizer NONDTM	40	40	40	40	40
Plasticizer Santiciser 140	10	10	10	10	10
Siloxane resin (50% by weight in toluene)—copolymer of $(CH_3)_3SiO_{\frac{1}{2}}$ units (a) and $SiO_2$ units (b), ratio of (a) to (b) 0.6	4	4	4	4	4
Stabilizer Barca 10	3				
Stabilizer Vanstay HTA		3			
Stabilizer Advance Liquid T150			3		
Stabilizer Dyphos paste				3	
Stabilizer Nuodex V-1048					3
<b>Physical Properties</b>					
Visc. Brookfield CPS	3000	6000	3500	3200	2500
Hobart mixer: Foam Density (lb./Cu.ft.)	30—35	35—40	30—35	35—40	28—33
Oakes foamer Foam Density (lb./Cu. ft.)	20—25	25—30	20—25	25—30	20—25
Gelation °F.	160—165	160—165	160—165	160—165	160—165
Fusion °F.	350	350	350	350	350



## EXAMPLE 5.

This Example illustrates the production of a low-density plastisol foam by increasing the plasticizer content.

- 5 Two formulations containing different amounts of plasticizer were prepared, with compositions as summarized in the following Table. Formulation A has 70 parts by weight

of plasticizer per 100 parts of resin, whereas formulation B has 120 parts of plasticizer per 100 parts of resin. When a continuous foamer of the Oakes type employing compressed air was used, a 20 pound per cubic foot foam could be produced from formulation A, as compared with a 12 pound per cubic foot foam from formulation B.

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Components	Parts by weight	
	A	B
Vinyl chloride polymer Tenneco 1755	90	90
Vinyl chloride polymer VC—265	10	10
Plasticizer XP—2007	20	40
Plasticizer NONDTM	40	40
Plasticizer Santicizer 148	10	40
Stabilizer Nuodex V—1048	3	3
Siloxane resin (50% by weight in toluene) copolymer of $(\text{CH}_3)_3\text{SiO}_{\frac{1}{2}}$ (a) units and $\text{SiO}_2$ (b) units—ratio of (a) to (b) about 0.6	4	6
Hobart mixer: Density (lb./cu.ft.)	30—35	23—25
Oakes foamer Density (lb./cu.ft.)	20—25	12—17

- 20 The use of the siloxane copolymer resin in the vinyl plastisol compositions in conformity with the invention thus yields a plastisol formulation which may be foamed by mechanically whipping air into it and subsequently gelling and fusing the mix using conventional techniques. The finished product is a high-quality flexible open-cell foam having small uniform cells. The liquid foam is more readily and economically prepared than by prior art techniques involving the use of thermally decomposable blowing agents or the dissolution of high-pressure inert gases in the composition. Moreover, the composition does not absorb water, nor is it as susceptible to thermal and age degradation as are prior art mechanically frothable plastisol compositions which contain alkali soaps.

## 35 WHAT WE CLAIM IS:—

1. A composition which is capable of being mechanically frothed with air to produce an open-cell vinyl chloride polymer foam, comprising a vinyl chloride polymer plastisol and, uniformly dispersed in the plastisol, a toluene-soluble siloxane copolymer resin consisting essentially of  $\text{R}_3\text{SiO}_{\frac{1}{2}}$  monovalent units and  $\text{SiO}_2$  tetravalent units in a ratio of monovalent units to tetravalent units from 0.3 to 0.7, where R is an alkyl radical, a monocyclic

aryl hydrocarbon radical, or a halogenated monocyclic aryl hydrocarbon radical.

2. A composition according to claim 1, wherein the plastisol comprises a vinyl chloride homopolymer and a plasticizer.

3. A composition according to claim 2, wherein the plastisol contains 100 parts by weight of the vinyl chloride homopolymer, 50 to 150 parts by weight of the plasticizer, and 1 to 10 parts by weight of the toluene-soluble siloxane copolymer resin.

4. A method of producing an open-cell vinyl chloride polymer foam, which comprises entraining air in a composition according to any one of claims 1 to 3 to form a liquid foam, heating the liquid foam to an elevated temperature to cause the foam to fuse into an open-cell foam structure, and cooling the fused foam to ambient temperature.

5. An open-cell vinyl chloride polymer foam produced by a method according to claim 4.

6. A flexible vinyl chloride polymer foam having a fine, uniform open-cell structure and comprising a fused vinyl chloride polymer plastisol foam containing a toluene-soluble siloxane copolymer resin consisting of  $\text{R}_3\text{SiO}_{\frac{1}{2}}$  monovalent units and  $\text{SiO}_2$  tetravalent units in a ratio of monovalent units to tetravalent units from 0.3 to 0.7, where R is an alkyl

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radical, a monocyclic aryl hydrocarbon radical, or a halogenated monocyclic aryl hydrocarbon radical.

5 7. A flexible vinyl chloride polymer foam according to claim 6, wherein the vinyl chloride polymer is a vinyl chloride homopolymer.

10 8. A flexible vinyl chloride polymer foam according to claim 7, containing 100 parts by weight of the vinyl chloride homopolymer, 50 to 150 parts by weight of the plasticizer, and 1 to 10 parts by weight of the toluene-soluble siloxane copolymer resin.

9. A composition which is capable of being

15 frothed with air to produce an open-cell vinyl chloride polymer foam, according to claim 1, substantially as hereinbefore particularly described in any of the Examples.

20 10. A method of producing an open-cell vinyl chloride polymer foam from a composition according to claim 9, substantially as hereinbefore particularly described in any of the Examples.

25 11. An open-cell vinyl chloride polymer produced by a method according to claim 10.

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